Study on the Load Sharing Mechanism of Main Girders in a Temporary Bridge with End-Plate Connections

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Evaluation of Structural Details of End-Plate Connections on Load Capacity and Redistribution in Temporary Bridges

BACKGROUND

- The demand for *temporary bridges with end-plate connections* has been increasing due to disaster recovery and the replacement of aging bridge infrastructure.(Fig.1)
- While end-plate connections offer simplicity and reusability, the effect of *bolt yield on load-bearing capacity and load redistribution mechanisms* remains unclear.
- Understanding residual *load-bearing capacity* beyond the service limit state is crucial for safe design and maintenance.

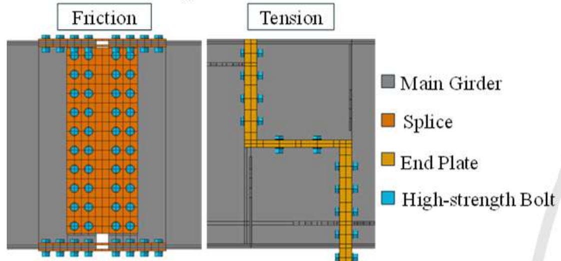

Fig. 1 Diagram of Friction Joints and Tension Joints

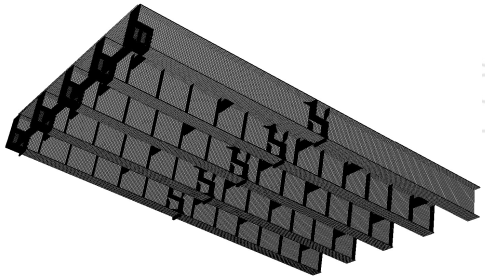
Fig. 2 Analysis Model and Mesh Division

METHOD

① Developed a 3D finite element model (FEM) of a temporary bridge with five girders connected via end-plate bolted joints.(Fig.2,3)

② Applied crane load (1,350 kN +450kN) to the critical position, considering dead load and friction (Fig.3,Load Factor λ)

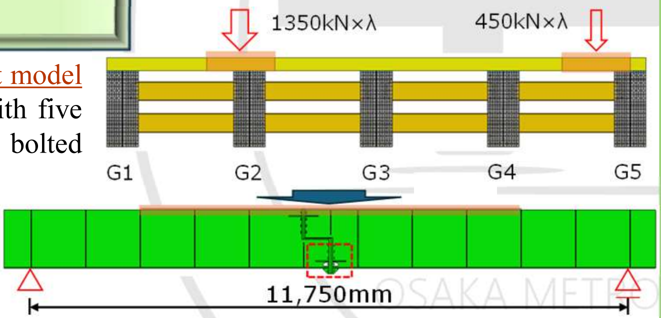

Fig. 3 Loads and Boundary Conditions

③ Simulated different bolt yield conditions (Case-Full, Case-2×2, 2×4, 2×6) based on known yield sequences.(Fig.4)

④ Conducted quasi-static analysis to **evaluate load redistribution** and **residual load-bearing behavior** by Rating Factor (RF).

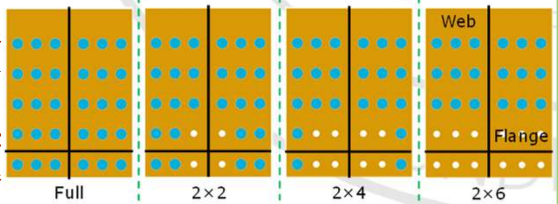

Fig. 4 Analysis Case and Yield Bolt Position

KEYWORDS

Temporary Bridge, End-Plate Connection, Structural Redundancy

RESULTS

Temporary bridges with end-plate connections possess inherent structural redundancy.

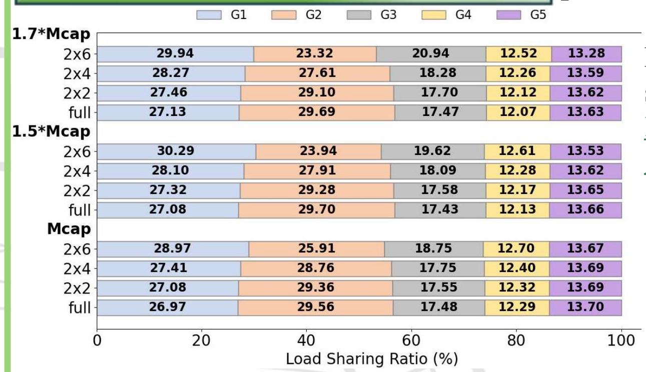

Fig. 5 Main Girder Load Sharing Ratio for Each Load

Fig.5 illustrated structural redundancy, showing that after partial bolt yielding, loads were redistributed from the G2 girder to the adjacent G1 and G3 girders.

Post-yielding, Fig.6 showed reduced stiffness and plastic deformation in the load-deflection response, indicating nonlinear behavior.

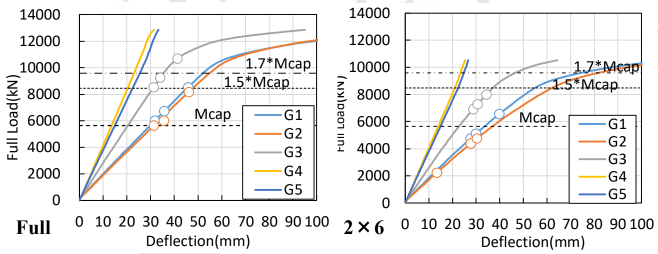

Fig. 6 Full Load - Deflection Relationship of Each Girder

As Fig.7, plastic zones extended from G2 to neighboring girders through cross beams and deck slabs, highlighting structural cooperation.

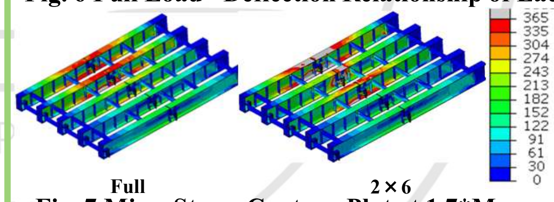

Fig. 7 Mises Stress Contour Plot at 1.7*M_{cap}

Even under severe yield (Case-2×6), RF evaluations confirmed sufficient residual capacity ,except in the most critical case, affirming the reliability of the design.(Formula.1,Table.1)

Table. 1 RF Calculation Result in Each Case

Case	Condition Factor ϕ_c	Ultimate Strength R(kN)	RF Value	Evaluation
Full	1	5646	1.38	Safe
2×2	0.95	5275	1.22	Safe
2×4	0.9	5121	1.11	Nearly Safe
2×6	0.85	4756	0.96	Slightly Dangerous

SUMMARY

Rating Factor (RF) was calculated using the following.

$$RF = \frac{\phi_s \phi_c R - \gamma_D D}{\gamma_L L} \quad \textbf{Formula. 1}$$

- End-plate connected temporary bridges maintain load-bearing capacity even under bolt yield due to ***load redistribution mechanisms involving cross beams and deck slabs***.
- ***Residual capacity evaluation using Rating Factor (RF) indicates sufficient safety*** margin except in severe yield cases (Case-2×6).